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ABSTRACT

The contributions of coal as an important energy source are reviewed in this booklet for teachers. It provides background information on coal, activities for classroom use, and an answer key for all the exercises. The introductory section includes information on: (1) coal and electricity; (2) reasons for using coal; (3) methods for extracting coal; and (4) historical perspectives on coal use. The remainder of the booklet is comprised of six activities that can be duplicated for classroom use. The activities contain maps, charts and diagrams that address concepts and problems related to the use of coal as an energy source. (ML)

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POWER FROM COAL

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A STUDENT HANDBOOK RECOMMENDED FOR UPPER ELEMENTARY AND MIDDLE GRADES

Dear Teacher:

This booklet is to help your class learn more about America's most abundant energy source—coal. By reading the text and checking the pictures and captions, your students should be able to complete the activities that begin on page 9. (You can remove these from the booklet and reproduce one for each student. The key—also removeable—is on page 23.)

Here are some key facts that your students can learn from working with this booklet:

- We use electricity every day and in many different ways. Without it our lives would be very different.
- More than half of our electricity comes from coal.
- We have much more coal in the U.S. than any other fuel.
- We use coal because it is abundant, affordable, and available.
- Mining coal is a modern process employing a well-trained, well-paid work force.
- Land that has been surface mined must, by law, be *reclaimed* (put back into productive, attractive form).
- When coal is burned, resulting air pollution must be controlled according to the law.

We hope that *Power from Coal* will be a useful addition to your library of energy teaching aids. For further information about coal, please write to Education Department, National Coal Association, 1130 17th Street, N.W., Washington, D.C. 20011.

Education Director
National Coal Association
1983

POWER FROM COAL

WHERE'S ALL THIS ENERGY COMING FROM?

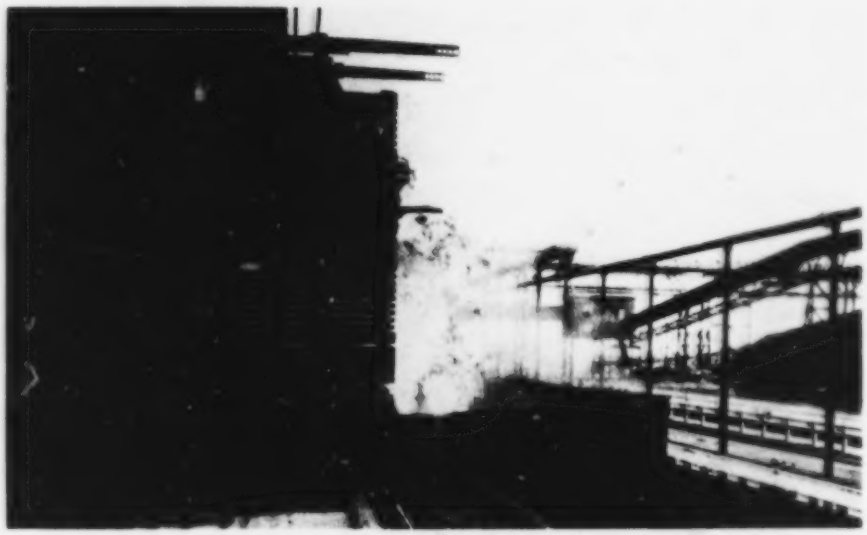
Take a minute to think about what you did this morning. You woke up, perhaps switched off your clock radio, reached for the light switch, and went into the bathroom for a hot shower. Did you use a hair dryer? toast a piece of bread? take some orange juice from the refrigerator? scramble an egg on the stove?

If you did any of these things, you were using electricity—a full time energy servant that most Americans take for granted. So much so, that many don't even know where it comes from.

There's something else you probably never think much about—coal. It's very likely you've never seen a lump of coal, although you may remember your grandparents talking about the black, sooty lumps they used to shovel into their furnaces.

What's the connection you may be asking? What does coal have to do with electricity? Isn't coal part of the past? And isn't electricity about as up-to-date as you can get? After all, it's electricity that allows us to play video games, watch television, cook in our microwave, type, program a computer, enjoy stereo music, heat and cool our homes, read at night—all of these things and dozens more that we count on and need.

But back to coal. There *is* a connection. More than half of the electricity used in the United States comes from coal that's burned at an electric utility plant. Coal creates the steam that drives huge turbines which make the electricity that is transmitted to our homes, schools, businesses and factories.



Our lives would be very different without electricity and steel. More than one half of our country's coal comes from coal-fired electric generating plants like the one shown opposite. Above, this load of white-hot coke, or baked coal, will be used to make steel.

Electricity

If your family uses an electric range, it means that you use about a half a ton of coal a year. If your water heater is electric, that's two tons a year. And another half-ton is burned to power your electric refrigerator. That's three tons of coal a year, just for three appliances. That doesn't include your lights, your electric washer and dryer, your air-conditioner—or any of the other electric appliances you may use.

Coal isn't the only fuel used to make electricity, of course. There are oil, natural gas, nuclear power, power from falling water (hydropower), and even the sun. But right now, in the 1980's, more than half of the electricity we use in the United States comes from burning coal.

Steel

But electricity isn't the only way you use coal. Automobiles, subway cars, buses, buildings, bridges, highways—all contain steel. And coal is one of the main ingredients in steel. In making your family's automobile, a pile of coal was used which weighed almost as much as the car.

Heat

Factories such as paper mills, food processing plants, and cement works also use coal for heat and for power.

Byproducts

Coal even helps produce food. How? Because once coal is burned, the *byproducts* (what's left over) are used to make fertilizers. Things you'd never dream of come from coal byproducts—things like perfume and aspirin, medicines, plastics, printers' ink and even some foods like margarine.

Coal also is sent to foreign countries to provide them with fuel for their electric utility and steel plants. It seems odd, doesn't it, that this fuel that we may never see plays such an important part in our lives. But it's there all the same.

WHY COAL?

Do you wonder why we still use coal, when we have oil and natural gas and nuclear power and even the sun as power sources? It's a good question and there are several answers to it.

There's A Lot Of It

For one reason we have a lot of it. If we used up all the coal we have in the United States at the same rate we're using it today, it would still last more than two hundred years. We have eight times as much coal as oil, and twenty times as much coal as natural gas. And even though nuclear power can be used to generate electricity, it has become more and more expensive and many people question the safety of nuclear plants. What about the sun, or solar power? No one has yet figured out a way to make large amounts of electricity from solar power cheaply. Today, solar power can help out—by heating water for example. But making huge amounts of electricity needed to serve factories and businesses is many years away.

We Can Afford It

Another reason for using coal is its cost. Most plentiful energy resources are expensive. But in the 1980's coal is usually cheaper than other fuels. If your town or city uses coal to make electricity, the chances are your family's electric bill is less than in areas where other fuels are used.

We Know Where It Is

Finally, we already know where most of our coal is. If you owned a company that was looking for oil or gas, you might spend millions of dollars trying to find these fuels—often with no luck. Mining coal costs lots of money too. But it's a whole lot easier and cheaper to find coal than oil or gas.

About half of our U.S. coal is mined underground. Large machines, like the longwall miner shown here, or continuous miners with rotating steel teeth, help rip the coal from the seam.

The big expense in mining coal is getting it out of the ground. It takes lots of equipment, lots of people and lots of planning.

GETTING IT OUT

One way of getting coal from the ground is to dig a hole, or *shaft*, all the way down to the coal. Then an *underground mine* is built, hundreds—sometimes thousands—of feet below the earth. It's rather like digging a well, except that when you reach the coal, tunnels are built back into the coal seam, creating what looks like a small underground town.

The miners who work underground go down the shaft in a large elevator, then ride through the tunnels in something like subway cars. The cars take them to the *coal face*—or the place where they will be mining that day.

Some miners operate large machines that rip the coal from its million-year-old home. Others drive *"buggies"* that take the coal to a *conveyor belt* that carries it out of the mine.

The Underground Town

In this little underground town there are hundreds of people working to keep the mine running smoothly. There is a *dispatcher* who keeps track by radio, phone and closed circuit TV of where all the rail cars are. There is a maintenance shop where *mechanics* work on mining machines that need repairs. There are *electricians* who make sure all the power sources are working safely. There's a *safety director* and his staff who check to see that all the laws of the company and the government are being met. There are *face bosses*—men who are in charge of a crew of approximately ten miners working together in one place. There's a *superintendent* who's in charge of the entire mine. And lots of others.

This dispatcher keeps track of all the comings and goings of coal and miners in an underground mine.

Safety First

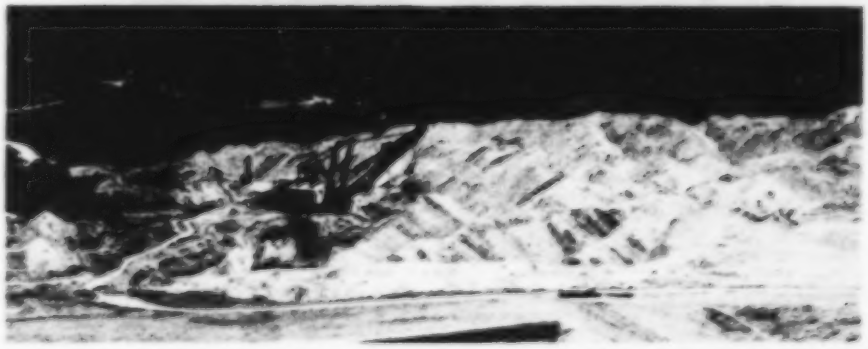
Safety is always on everyone's mind in an underground mine. Like any work under the earth's surface, there are dangers to watch for. One is to make sure the roof is good and secure. Miners do this by drilling metal rods into the mine ceiling. Another danger is gas that can explode. So miners check the air every twenty minutes to make sure there's enough fresh air blowing through the mine.

When you learned to ride a bike—or when you learn to drive a car—there are certain safety rules you must obey. The same is true for miners—only more so. They work with very powerful machines, electricity, moving conveyor belts, and heavy hand tools. You can imagine how important it is to do all these jobs with care. Before they even go to work in the mines, they are trained so they'll know how to work safely.

Moving the Earth

Underground mining is one of two ways of getting at coal. If the coal is fairly close to the surface, there's no need to dig a shaft. The dirt and rocks, or *overburden*, above the coal seam can be taken away with *draglines*. Then the coal is broken up with explosives, loaded onto trucks with *power shovels* and taken to a plant where it's washed and sorted according to size.

As you can imagine, *surface mining* is less complicated than underground mining—and less expensive. But there is one problem. What about the land after it's been torn up by strip mining? It doesn't look good.



(Top) This miner is checking for methane gas, an important job in keeping an underground mine safe. (Middle, left) The bucket of the machines used to surface mine coal are sometimes large enough for several men to stand in. (Middle, right) Experts from mining companies are always on the lookout for new plants that will grow on surface mined land. (Bottom) At this surface mine in Ohio you can see a dragline surrounded by reclaimed land.

And Putting It Back Again

The answer is to restore (or *reclaim*) the land. That means smoothing the land with a bulldozer, fertilizing it, planting it, watering it—in other words, treating it like a giant garden. Before too long, it looks like it did before—or maybe even better.

Do you live in Ohio? If you do, there is a huge campground that once was a strip mine. In Indiana, there are several parks in the southern part of the state that are on reclaimed land. How about West Virginia? There's a high school there built on a mountaintop where, not too long ago, draglines and trucks were taking out the coal. Out west, in Arizona, there are cattle grazing on an old mine site. Bet if you drove past these places you'd never be able to tell them from land that's never been mined.

The People Who Mine

What's it like to live in a mining town? You may already know if you're from certain parts of West Virginia, Kentucky or Wyoming. (Those are three of the states that mine much of our coal.) You know that miners usually work eight hour *shifts*, sometimes at night. They make good money, and live pretty much like other people around the United States—driving cars and pick-ups, shopping at the malls, going to movies, fishing and hunting. A lot of them take pride in doing a tough job like mining. Even some women mine coal these days—a far cry from the days when they were considered bad luck in the mines.

Most coal that's been mined goes to electric utility plants where it's used to make electricity. But, as we've read, it also goes to steel mills, factories, and ships that take it overseas.

To Market, To Market.

Trains carry most of the coal after it's been mined. Often the trains will have one hundred cars or more. They're called *unit trains* and they go from the mine directly to their destination with no stops in between.

If a mine is near a river the coal may travel by *barge*, like the ones you can see on the Ohio and Mississippi Rivers. Sometime soon coal will probably be mixed with water and sent through underground *pipelines* from one part of the country to another.

Moving coal is a big business and it is expensive. Sometimes it costs as much to move coal from one place to another as it does to mine it. That's part of the electric bill your parents pay.

Cleaning the Air

It is the *carbon* in coal that makes it burn. There is also *sulfur* in coal, and it can cause air pollution when coal is burned. But so far, no one has discovered an energy source that doesn't have some sort of problem. And sulfur is coal's.

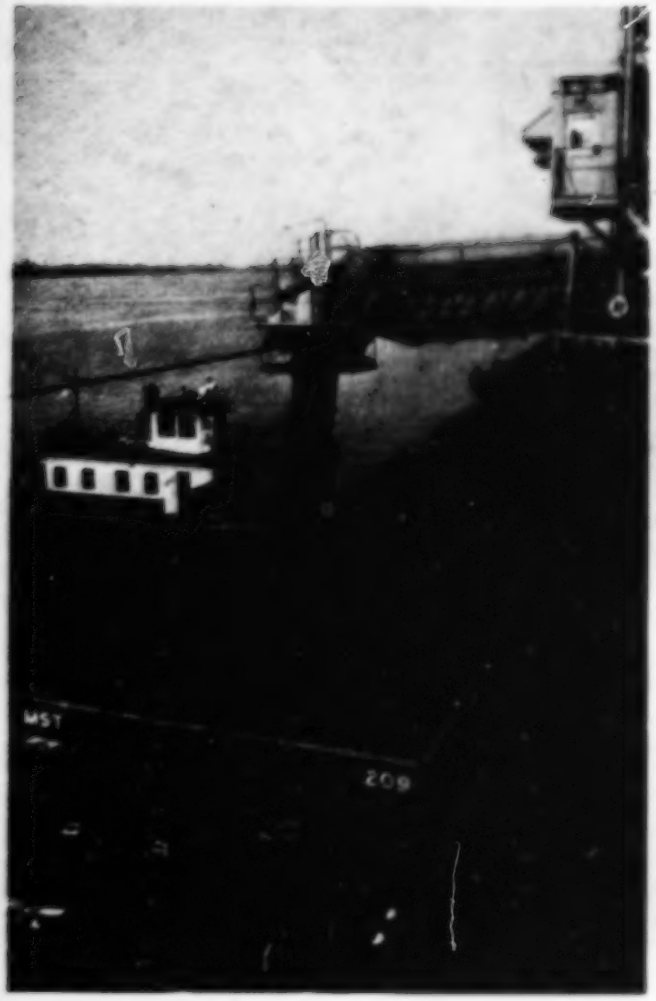
There are ways to remove part of the sulfur, either before or after the coal is burned. One way is to wash the coal before it's burned. Another is to crush the coal and combine it with limestone and air when it's burned. Probably the way that most people know about is to catch the sulfur in a giant piece of equipment called a *scrubber* after the coal's been burned.

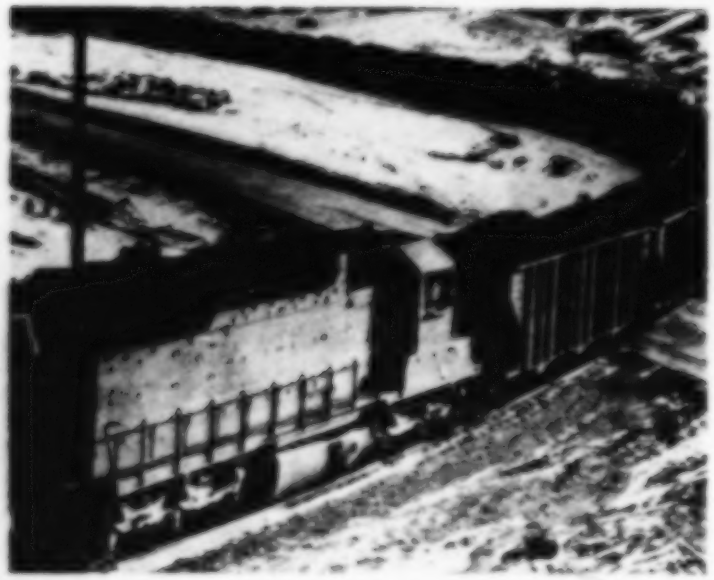
All of these ways are still pretty new—and they cost lots of money. Taking the sulfur out of coal means that your family's electric bill will probably be more. That's the price we pay for clean air.

People are important in mining coal. Greasers, or mechanics (top left) keep underground coal mining machines in good order. This woman (top right) is getting ready to operate a bulldozer at a surface mine. (Bottom) A crew of miners start off for their day in an underground mine.

Way Back When

All this coal we're using today goes back millions of years. Look at a lump of coal and it will be black, solid and slightly sooty. If you carved a very thin slice off that lump (the way scientists in laboratories do) you could put it under a microscope and see bands of yellow, red, orange and black. What you'd see, magnified hundreds of times, would be tiny pieces of carbon and sulfur. That's what was left over from the plants and trees that grew millions of years ago when coal was being formed.



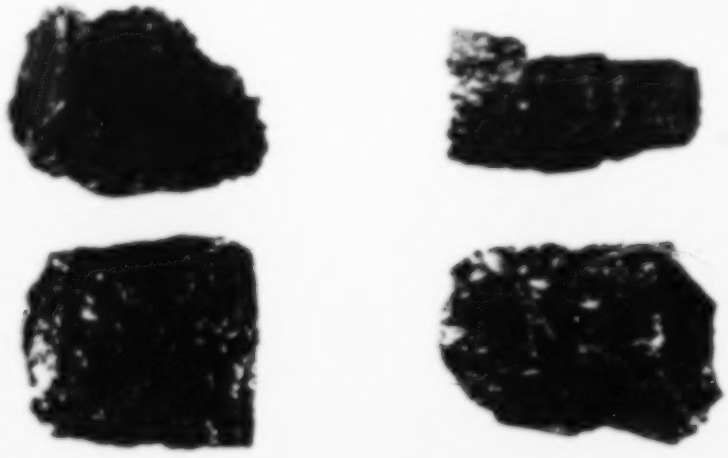


Coal travels from the mines to customers in several ways. Barges (above) are used when a mine is close to a river, such as the Ohio or Monongahela.

Trains, (top) now move more than three-fourths of our coal. About ten percent of our coal goes overseas to foreign countries in huge ships, like the one shown at bottom.

In a way coal is one of our oldest forms of solar power, since it is made up of plants that originally got their life from the sun. Back in the *Carboniferous*, or coal bearing, *Age*, there were giant ferns and grasses as tall as our trees today. They flourished in the damp, swampy weather, and when they died the water and mud washed over them, leaving ground for new plants. So, over the years, layers and layers of these plants were buried under prehistoric forests and seas.

The weight of the water and mud compressed these plants over the ages, and finally left the rich layer of carbon that we now call coal.



When coal was formed, the different amounts of pressure and heat formed four different kinds of fuel. Peat (top left) is not really coal, but can be burned with a lot of smoke. Subbituminous coal (top right) gives off more heat and less smoke than peat. Bituminous coal (lower left) is our most plentiful kind of coal in the U.S. Anthracite is very hard, very high in heat content, and very scarce.

FROM PAST TO PRESENT

Do you remember reading or talking about the *Industrial Revolution*? That's the period back in the middle of the 1800's when people began to give up farming and start working in factories. It made a tremendous difference in the way people lived—and coal was responsible for the whole thing.

It all began when a man named James Watt invented the *steam engine*. That engine made it possible for machines to do work that men or animals had had to do before. At first Mr. Watt burned wood to create the steam that powered his new gadget. But then he discoverd coal, which burned longer and hotter. When factories began springing up all over England—and in the United States—coal was in hot demand.

Mining for coal used to be a pretty grim job, with round the clock hours, unsafe conditions, and even children doing hard and dangerous work. But by World War II, conditions were entirely different. Pay was good, the mines were modern and safer, and machines had taken over a lot of the work than men and mules had done before.

By the 1900's not only the factories were using coal. People used it to heat their homes until they discovered that oil and natural gas were cleaner and easier to use. Ask your grandfather if he remembers shoveling coal into his furnace when he was young.

Have you ever been to the Smithsonian Institution in Washington, D.C.? If you have, maybe you've seen the huge train locomotive in the American History Museum. This train engine—and hundreds like it—used to pull trains full of people and freight all across the United States. And they burned coal to create their power. But that use of coal disappeared too, when the railroads started using diesel fuel.

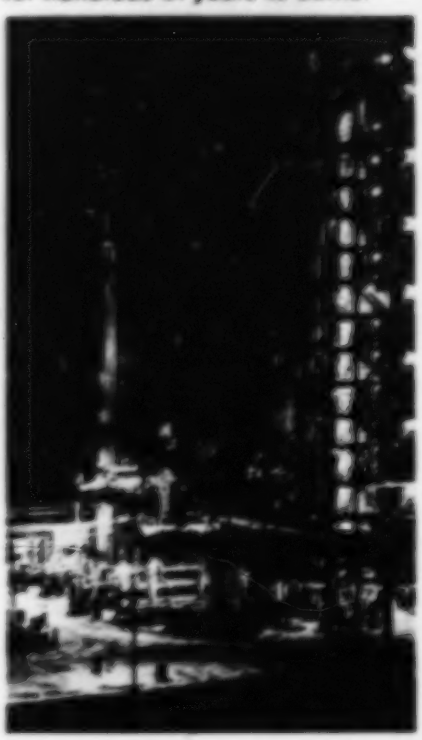
If you go *way* back in America's history, you'll find out that the Indians were using coal long before any of the early settlers got here. The Hopis were probably the first to use it—not for electricity, machines or heat, but to bake the pottery that they made from southwestern clay.

This is what the world probably looked like millions of years ago in the Carboniferous Age when coal was being formed.

Try to imagine for a minute that you are an early pioneer in the United States. There is only a rutted path for your covered wagon. At night you camp out in the woods and cook your food over a campfire. Your only heat comes from the fire and layers of clothing. You entertain yourself and family be telling stories and singing. Any hard work, like building a house, you must do yourself or with the help of family and friends.

Now think how much easier life was for the people who came later—people who could take trains from New York to California. Those who could use machines for their heavy work, or could fire their furnace once a day to heat their house. Or those who could drive across a superhighway or turn on a switch to provide light at night.

Coal made it all possible. And, if you think back to this morning, it's still working in your life—making it easier and more pleasant. It's a good feeling to know that coal will be around to help out for hundreds of years to come.



Coal can be changed into gas or oil at synfuels plants like this one. It's very expensive, however, and now other fuels are still much cheaper.

ACTIVITY #1

Complete the following paragraph with the words listed below.

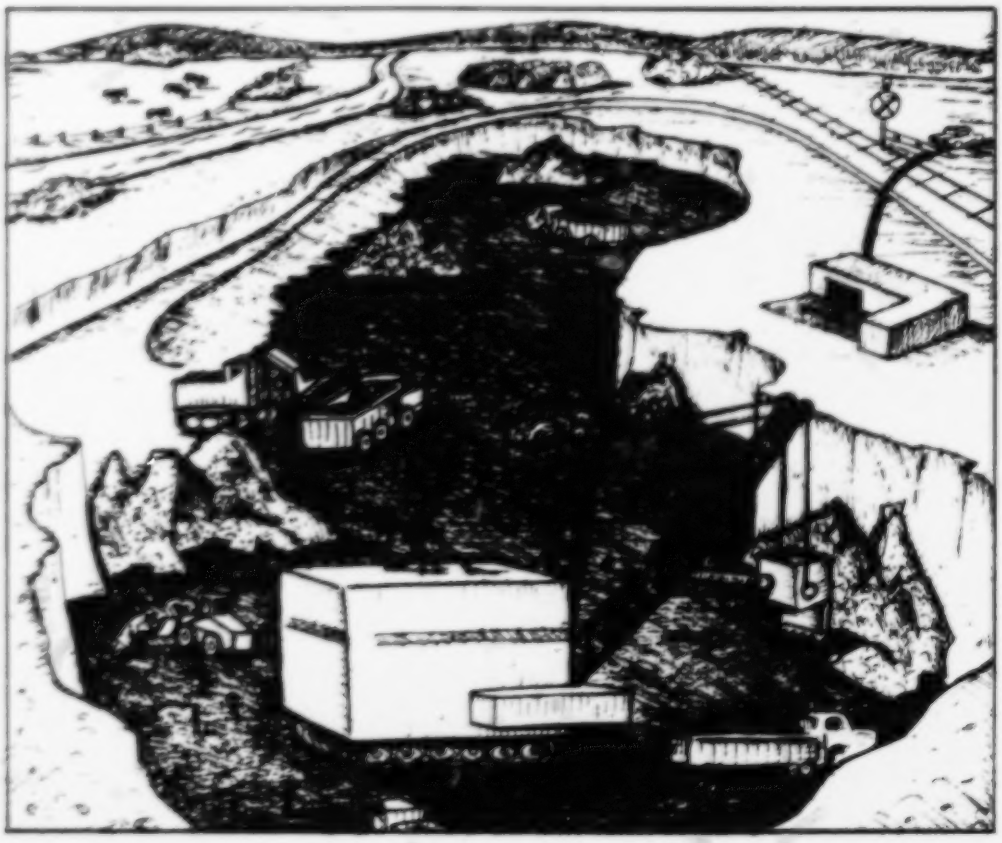
steel cement electricity

byproducts carbon

Coal was formed millions of years ago and is made up mostly of _____. Today we use it to produce more than half our _____. It is also used to make the _____ used in bridges, highways, automobiles, and buildings. The heat from coal is also used in some factories such as _____ plants. Other things like asprin, cosmetics, plastics, and fertilizers are made from coal _____.

ACTIVITY #2

Imagine that you are the president of the Brown Coal Company. You own and operate a large surface coal mine. Look at the picture below and decide what some of your expenses will be, then list them. Who are possible buyers for your coal? How will you get your coal to your customer?



Expenses	Possible Customers	Transportation

ACTIVITY #3

Number the following statements to show in what order they occured in history.

Gas and oil become popular as heating fuels

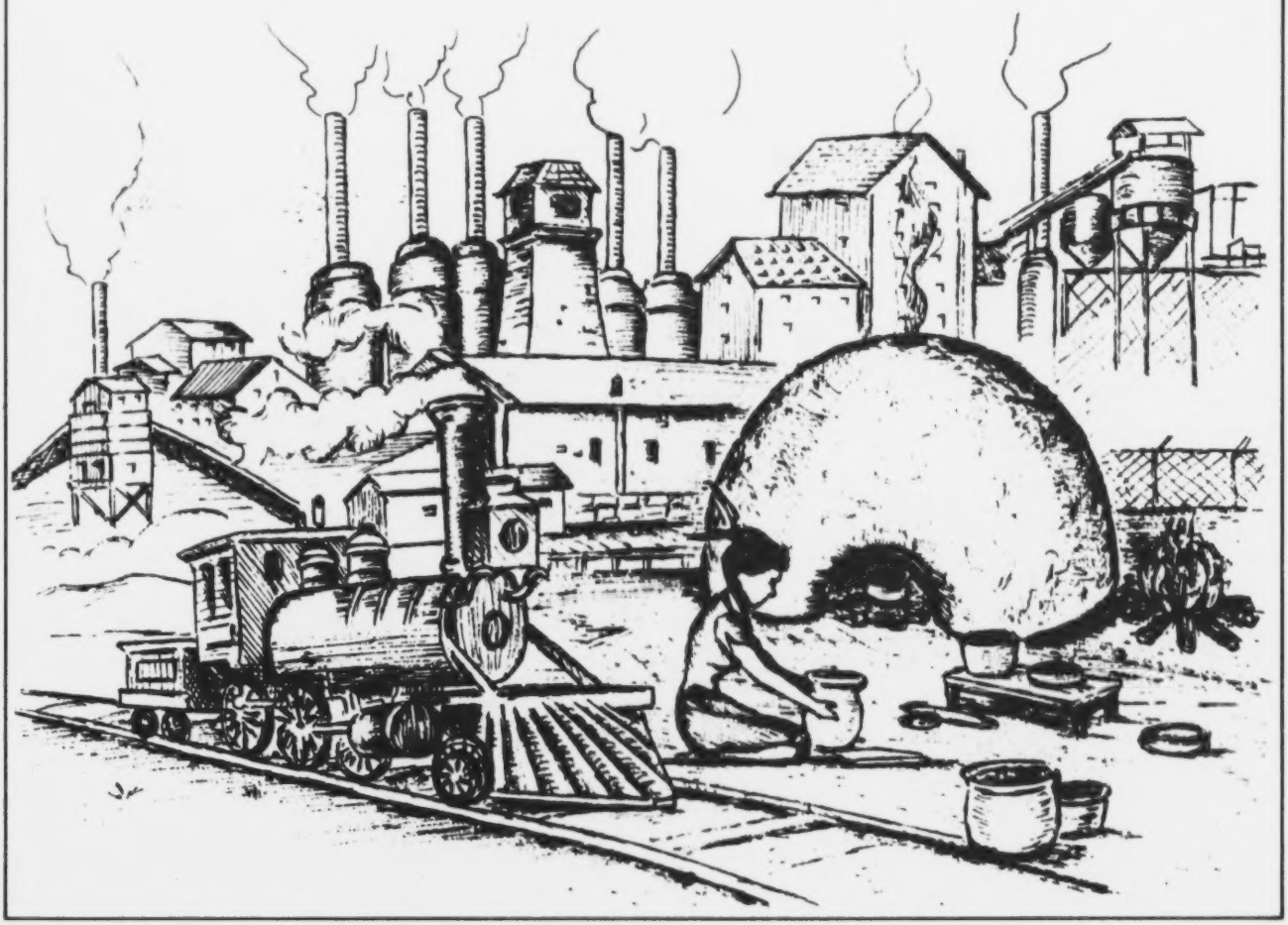
Coal becomes America's most used fuel

James Watt develops steam engine

Hopi Indians use coal for firing pottery

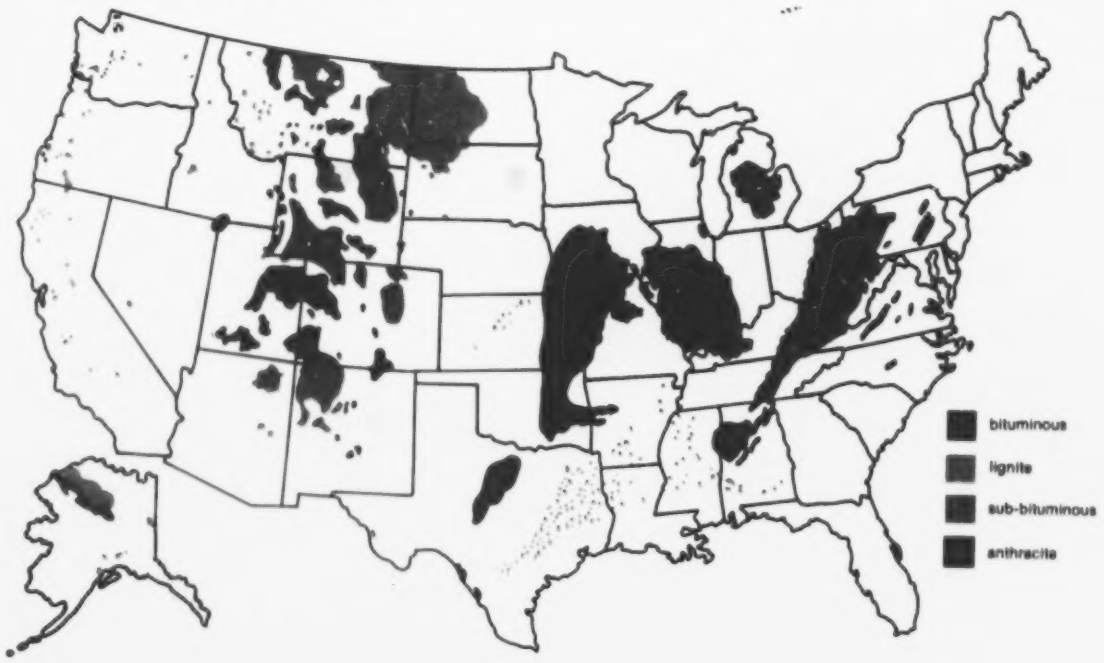
Industrial Revolution sweeps America

Coal used to generate more than half of U.S. electricity



ACTIVITY #4

This map shows where various kinds of coal are found in the United States. It also tells you which states mine coal and how much they produced in the year 1981.



1981 U.S. Coal Production, By State

State	Total	State	Total	State	Total
1. Kentucky	149,068	10. Indiana	29,364	19. Washington	4,810
2. West Virginia	112,814	11. Alabama	24,887	20. Missouri	4,715
3. Wyoming	102,715	12. Colorado	19,531	21. Maryland	4,453
4. Pennsylvania	80,800	13. New Mexico	18,916	22. Alaska	800
5. Illinois	51,720	14. North Dakota	17,995	23. Kansas	785
6. Virginia	45,500	15. Utah	13,809	24. Iowa	655
7. Ohio	37,358	16. Arizona	11,614	25. Arkansas	280
8. Montana	33,380	17. Tennessee	10,600	26. Georgia	5
9. Texas	32,892	18. Oklahoma	5,250	TOTAL U.S.	814,716

1. Fill in the names of the ten states that produced the most coal in 1981.

2. Can you tell from this map how many tons of coal we have in the United States? Why or why not?

3. Notice that there are large deposits of coal shown in Michigan, yet coal is not mined there. Can you guess why not?

4. Does your state produce coal? Does your electricity come from coal?

ACTIVITY #5

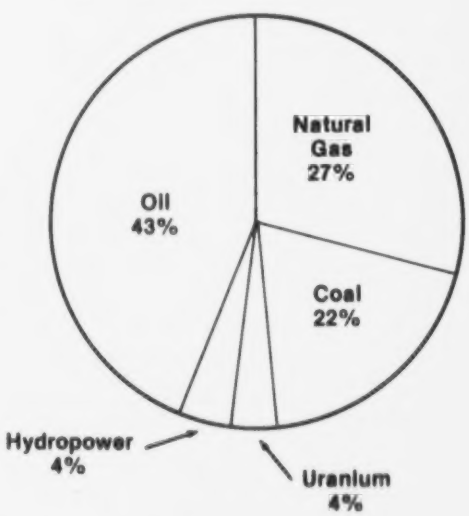
Our Energy Resources

In the United States we have lots of some fuels and not so much of others. In the graph below put the name of the fuel in the space that shows how much of that energy source we have. Now add the percentage that each fuel represents in our total reserves.

Coal
Oil and Oil Shale
Natural Gas
Uranium
10%, 82%, 4%, 4%

How Do We Use the Fuels We Have?

The United States uses lots of energy for all different kinds of things—electricity, transportation, manufacturing, recreation. Take a look at how much of each of our fuels we used for all our energy needs in 1981. Now compare it to the graph above that shows how much of these fuels we actually have. 1. Are we making good use of what we have? 2. Are we using only fuels that come from the United States? 3. Are there ways we can improve our energy use?



Where our Energy Came From in 1981

ACTIVITY #6

Problems and Solutions

There is no such thing as a perfect energy source. Coal, too, has its problems. But America was built on the idea that problems can be solved. Take a look at the coal problems listed below, then write down ways in which these problems are being solved.

Problem

Coal Mining Can Be Dangerous

Solutions

_____ _____

_____ _____

Problem

Surface Mining Tears Up the Land

Solutions

_____ _____

_____ _____

Problem

Burning Coal Can Cause Air Pollution

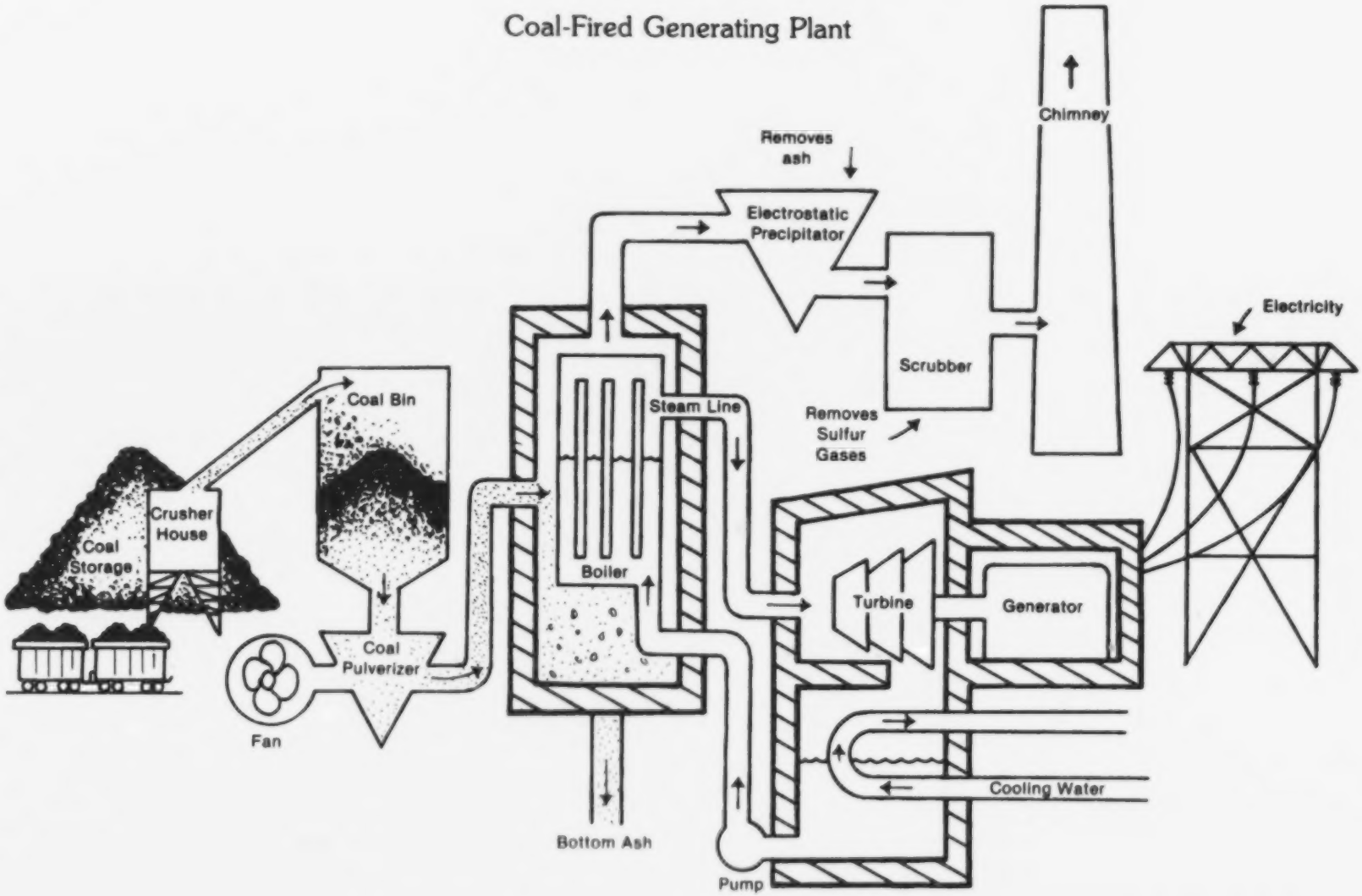
Solutions

_____ _____

_____ _____

INFORMATION SHEET

Coal-Fired Generating Plant



NOTE: Not drawn to scale. All systems not shown.

21

TEACHERS KEY TO ACTIVITIES

ACTIVITY #1

Carbon, electricity, steel, cement, byproducts

ACTIVITY #2

Expenses

- purchase of land
- cost of construction of mine buildings
- cost of equipment
- wages for miners and other employees
- cost of reclaiming land

Possible customers

- electric utilities
- steel mills
- manufacturing plants
- foreign countries

Transportation

- railroads
- barges
- ships
- pipelines (future)

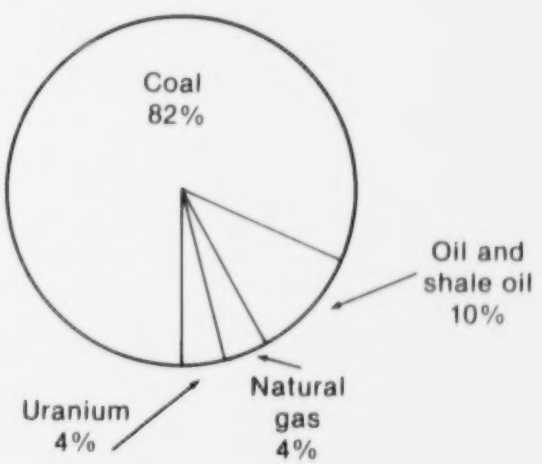
ACTIVITY #3

- Hopi Indians use coal for firing pottery
- James Watt developes steam engine
- Industrial Revolution sweeps America
- Coal becomes America's most used fuel
- Gas and oil become popular as home heating fuels
- Coal used to generate more than half of U.S. electricity

ACTIVITY #4

1. See any U.S. map.
2. No. This map does not show the depth of the coal seams.
3. Coal in Michigan is in very thin seams that makes it uneconomical to mine.
4. Check map and local utility.

ACTIVITY #5



Continued on page 24

1. We could use more of our abundant coal for generating electricity and allow natural gas and oil to be used for home heating and transportation.

2. We import more than 40% of the oil we use in the United States.

3. Use this question as a basis for class discussion.

ACTIVITY #6

I.

- National Coal Mine Health and Safety Act requires safe practices in the mines.
- All underground and surface miners trained in safe methods of performing jobs
- Special design of mining equipment to protect miners
- Protective clothing for miners.
- Regular inspections of mines by company and government safety experts.
- Weekly safety meetings for all miners.
- Special safety campaigns aimed at eliminating accidents.

II.

- National Surface Mining and Reclamation Act requiring speedy, successful reclamation of all strip mined land.
- Planning for reclamation before strip mining takes place.
- Research into new plant strains for areas where rainfall is slight.
- Penalties for companies not reclaiming land.

III.

- National Clean Air Act requiring coal burning plants to limit pollution.
- Equipment, called precipitators, that take ash out of air after coal is burned.
- Equipment, called scrubbers, that remove sulfur gases from the air after coal has been burned.
- System for burning coal—called fluidized bed—that removes sulfur while coal is being burned.